Urban Climate xxx (2016) xxx–xxx

Contents lists available at ScienceDirect
Urban Climate
journal homepage: http://www.elsevier.com/locate/uclim

Developing storylines for urban climate governance by using Constellation Analysis — insights from a case study in Berlin, Germany

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ARTICLE INFO

Article history:
Received 26 June 2015
Received in revised form 26 November 2015
Accepted 22 February 2016
Available online xxxx

Keywords:
Climate change adaptation
Urban heat
Urban governance strategies
Urban development
Storylines
Constellation Analysis

ABSTRACT

Urban populations are at large risk from climate change and particularly extreme heat events. While there are various studies about heat risks, including those based on modeling experiments examining hazards and vulnerability related to heat (exposure, sensitivity and adaptive capacity), methods to develop urban heat scenarios built upon in-depth knowledge on urban governance are missing. The aim of this paper is to create exploratory and anticipatory storylines for heat adaptation in urban planning using the method of Constellation Analysis. Focusing on the case of Berlin, Germany, the complex sets of urban governance measures that exist on different spatial levels are introduced. From the analyzed governance and planning processes three exploratory storylines for 2040/2050 are derived. Additionally, the paper presents an anticipatory storyline of a "heat adapted city". The limitations and benefits of these perspectives and the need for quantitative and spatially explicit scenarios are discussed. Systematic approaches to identifying urban heat governance constellations and deriving respective storylines are of utmost importance for discussing possible urban development paths with different stakeholders.

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http://dx.doi.org/10.1016/j.uclim.2016.02.006
2212-0955 © 2016 Published by Elsevier Inc.

1. Introduction

As a result of urbanization increasingly large shares of the world population are living in cities. Cities are merging points of economic, political, social and cultural life, and as such face a higher risk of damages from climate hazards (e.g. Carter, 2011; Revi et al., 2014), including the urban heat island effect (e.g. Rizwan et al., 2008). Limited vegetation and resulting evapotranspiration, large shares of dark surfaces with low albedo, building configurations that trap heat, and the concentrated generation of heat from anthropogenic activities lead to higher temperatures in cities than in the surrounding countryside (Oke, 1982). Distinctive microclimates are known to create hotspots of urban heat risk within cities (Lowry, 1967) and global warming from greenhouse gas emissions is intensifying heat in cities (Wilby, 2007).

Heat events put urban infrastructure systems and especially inhabitants at risk. They have been associated with higher mortality and morbidity rates and a significant lowering of the well-being of urban populations (e.g. Breitner et al., 2013; Harlan et al., 2014; Kravchenko et al., 2013; Scherber et al., 2013). Many studies on urban heat risks have been undertaken in hot climates, for instance in Phoenix, Arizona, (e.g. Baker et al., 2002; Harlan et al., 2006), Houston, Texas (e.g. Hitchcock, 2011) and Seoul, South Korea (e.g. Eum et al., 2013). Mid-latitude cities in temperate climate zones, such as Berlin, Germany, are only beginning to get attention. A statistical analysis by Scherer et al. (2014) identified a mortality risk of about 1600 excess deaths per year associated with heat in Berlin. The authors concluded that dealing with heat risks poses increasing challenges for policy makers, urban planners and architects in mid-latitude cities.

Referring to the IPCC framework on climate change risk and vulnerability (IPCC, 2000) McGregor et al. (2007) describe human vulnerability to heat as a function of the degree of exposure to heat hazards, the sensitivity to changes in weather and climate and adaptive capacity. Age, income, gender and health status are factors influencing individuals' sensitivity (Harlan et al., 2006; Schuster et al., 2014). Individual vulnerability also depends on the specific spatiotemporal exposure to heat. Adaptive capacity encompasses the available means of a person or society to target the risks induced by a hazard and reduce respective vulnerability (IPCC, 2000 in Carter et al., 2015). Assessing vulnerabilities to urban heat requires consideration of a complex set of factors linked to the hazard and its impacts in their spatial and temporal patterns. It is also necessary to study various policy and decision-making strategies.

Urban development is a policy field of specific importance for the reduction of vulnerability to heat. It covers governing the materiality of the urban fabric and at the same time involves social, ecological and economic aspects of spatial development (Koch, 2010). According to Stone (2012) changing land-use and urban growth are powerful means to alter local climate and to counteract the risks expected from global warming due to greenhouse gas emissions over the next half century. Land-based heat mitigation can lead to a measurable decrease of local temperatures.

There is considerable research on urban development and climate. The literature addresses urban climate change adaptation (see e.g. Carter, 2011; Winsvold et al., 2009), heat as a particular challenge (see Carter et al., 2015; Kleerekoper et al., 2012), andstrategies which can contribute to city cooling, like the arrangement and design of buildings and the quality of their surroundings (e.g. Jänicke et al., 2014; Schwarz et al., 2011; Stone and Rodgers, 2001). There has, however, not yet been research on how urban governance influences possible pathways of urban development with regards to reducing vulnerability to heat. Different governance strategies and their interplay may hinder or result in synergies for sustainable urban development.

To study the complex sets of factors influencing societal problems, Constellation Analysis, an interdisciplinary research tool was developed (Schön et al., 2007). The approach allows analysis of the multiple coexisting governance strategies for urban development and climate. Bulkeley and Kern (2006) identify various governance strategies: *self-governing*, *governing through enabling*, *governing by provision* and *governing by regulation*. These are relevant for understanding urban governance constellations.

Also important is to recognize that policies are dynamic and can be altered in the light of experience. Policy makers can react proactively or reactively to changes in their surroundings, like a changing climate. Social agency and reflexivity, however, make forecasting socio-economic trends a challenging task (Berkhout et al., 2002).

Scenario analysis is an important method for testing different adaptation strategies and to support decision-making processes (Hagemeier-Klose et al., 2013). Capable of capturing a broad range of possible futures, scenarios can include uncertainties inherent in a variety of potential developments and are a popular method used in climate change and land-use change studies (Hagemeier-Klose et al., 2013; Mahmoud

Please cite this article as: Mahlkow, N., et al., Developing storylines for urban climate governance by using Constellation Analys..., Urban Climate (2016), http://dx.doi.org/10.1016/j.uclim.2016.02.006